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## NOTES ON DILARIDÆ AND BEROOTHIDÆ, WITH SPECIAL REFERENCE TO THE IMMATURE STAGES OF THE NEARCTIC GENERA (NEUROPTERA)

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To students of neuropteroid insects, as well as to entomologists interested in specialized types of holometabolous larvæ, it will be significant that the immature stages of *Nallachius* and *Lomamyia* have been found. *Nallachius* is the only Nearctic genus of Dilaridæ and contains two species in the United States, both of which were originally referred to the genus *Dilar*. *Lomamyia* is the sole Nearctic genus of Beroothidæ, represented in this country by 10 species, and, like *Nallachius*, they are all relatively rare insects. With the exception of the eggs and first-stage larvæ of *Spermophorella*, an Australian beroothid genus, the young stages of these two families have been entirely unknown. Though some details of the biologies of *Nallachius* and *Lomamyia* are still unknown, the main features may now be presented. Their larvæ prove to be related, though perfectly distinct, predators which attack soft-bodied insects.

The discovery and recognition of the young of these insects may be largely attributed to the collecting zeal and generous cooperation of my colleagues, William H. Anderson and Herbert S. Barber. Dr. Anderson collected the male allotype<sup>1</sup> of *Nallachius americanus* (McL.) in 1939, and has also collected four lots of larvæ, with

<sup>1</sup> Designated by Carpenter (1940) subsequent to the original description, 1881. This specimen was reared, but the cast skins were not recovered.

one lot of which two pupæ were associated. The pupæ died before maturity, but possess the characters of the adult sufficiently well to permit identification. A cast larval skin of one is identical with larvæ which he collected. This material of *americanus* was first correctly identified in 1945 by Henry K. Townes. More than 50 years ago the late H. G. Hubbard collected a single nearly fully grown larva of *Lomamyia* which could not then be identified. A similar, though fully developed, larva taken in 1941 by R. J. Kowal likewise could not be named until the key to this identification puzzle was secured through study of first-stage larvæ hatched by Mr. Barber in 1919 from eggs laid by a captive *Lomamyia*.<sup>2</sup> F. M. Carpenter of Harvard University made some most helpful suggestions, when he learned of the study in progress, and I am also grateful for the photograph of *Nallachius* wings (fig. 1) which he kindly offered to make. Finally, I would express my appreciation to George E. Wallace of the Carnegie Museum for the loan of adult specimens of *Nallachius americanus* and the privilege of retaining two of them for the United States National Museum.

In this paper I have included a few notes on the distribution and variation of *Nallachius americanus*, though my primary object is to compare the immature stages of *Nallachius* and *Lomamyia* morphologically and to discuss the relationship of the Dilaridæ and Berothidæ to other families in the light of present information.

#### DILARIDÆ

##### The genus *Nallachius* Navas

*Nallachius* Navas, 1909, Mem. Real Acad. Cienc. Artes Barcelona, vol 7, pp. 627, 666. Genotype: *Dilar prestoni* McL., 1880, designated by Navas (1914).

Carpenter's revision (1940) and subsequent additions (1942, 1947) should be consulted for information on the taxonomy and distribution of the Nearctic Dilaridæ and

<sup>2</sup> The specific identity of this female is uncertain. It was determined as *L. flavicornis* (Walk.) by A. N. Caudell in 1919, but determinations current at that time are rendered untrustworthy by the description of several species then unrecognized. The specimen was utilized for morphological study and is not now available.



Berothidæ. The only sizable collection of *Nallachius* adults yet reported is that of Steyskal (1944), who collected six females and 21 males of *americanus* flying around a single dead tree in Detroit, Mich., during the months of June and July. It is possible that larvæ oc-

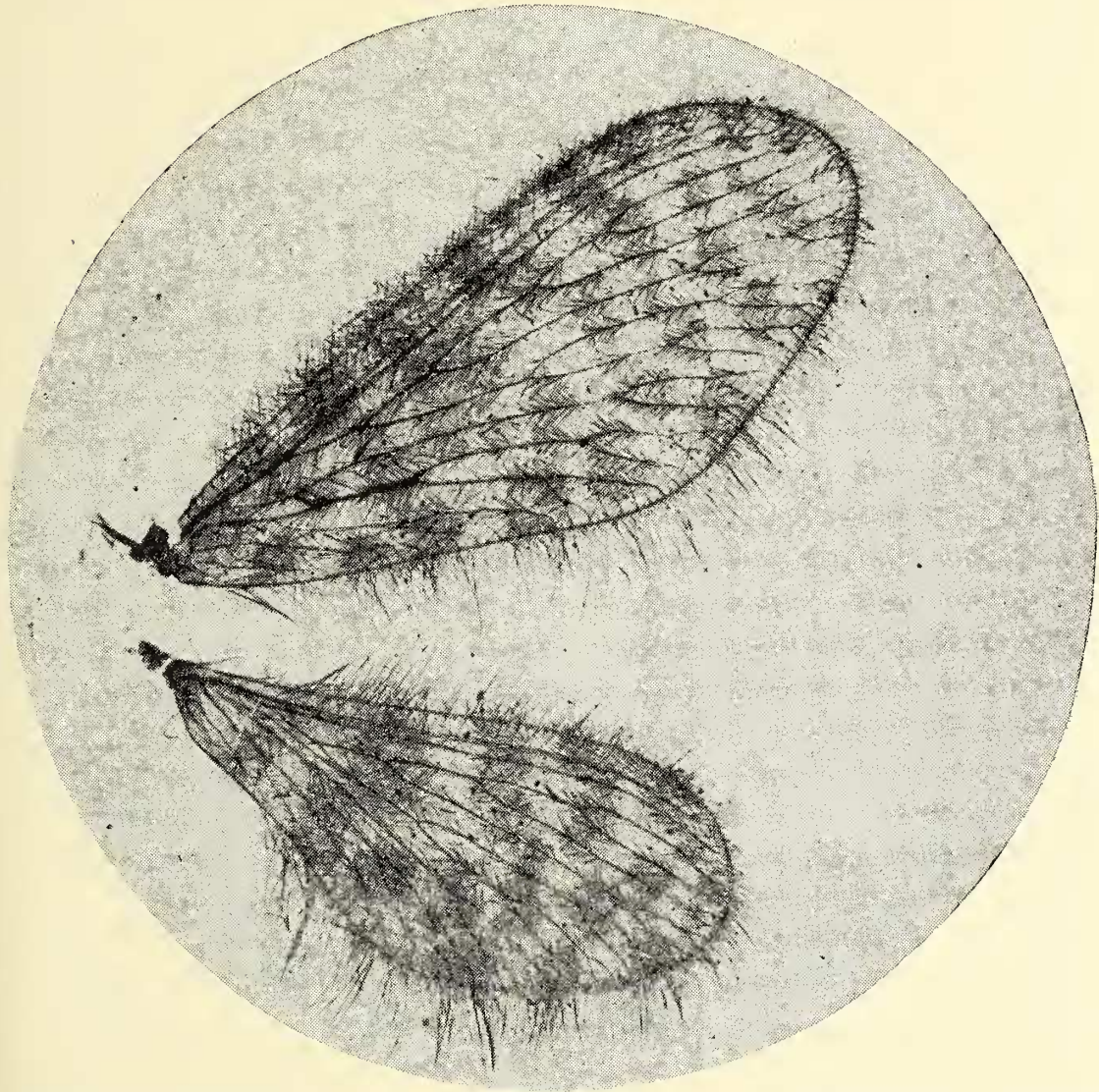


Fig. 1. *Nallachius americanus* (McL.), female, dorsal view of right wings. Length of front wing, 7.5 mm. Brookline, Pittsburgh, Pa. Photograph by F. M. Carpenter.

curred in this tree, and also that oviposition was in progress.

Previously unreported adult material of *N. americanus* consists of four males and four females from the Pittsburgh area of Pennsylvania, one male from Odenton, Md., and a male from Bainbridge, Ga. (Detailed data appear

in the section headed "Material examined.") The wings (fig. 1) are specific for this insect, but male genitalia should be examined to confirm identifications whenever possible. A photograph of the wings has not previously been published, though Costa Lima (1943, figs. 54, 55) has given excellent photographs of the Brazilian *N. prestoni*. Size variation is indicated by the Pittsburgh series, a front wing of each of the males measuring (length in millimeters) 5.1, 4.8, 4.8, 3.6, respectively, and a front wing of each of the females from the same series measuring 7.5, 6.3, 6.1, 5.6, respectively. Forewings of the Odenton and Bainbridge males measure 4.2 and 4.3 mm. Male antennæ usually include 9 pectinations (plus the apex of the central axis), though a few specimens have 10 pectinations.

#### Immature stages of *Nallachius americanus*

*Eggs*.—One female examined (opposite Homewood Cemetery) has a cream-colored egg held at the apex of the ovipositor. It measures about  $0.37 \times 0.13$  mm. and is rounded oblong.

*Larva*.—General body shape slender, elongate, convex (fig. 6); body setæ sparse, inconspicuous, long, and slender; spiracles well developed on mesothorax and abdominal segments I–VIII, scarcely noticeable without compound microscope. Head with elongate, somewhat blunt jaws of usual Planipennia type (figs. 11, 14); no fracture line of jaws evident; mandible and maxilla subequal in size; apex of maxilla with sensory setæ and spiculelike teeth; front triangularly produced between and anterior to antennal bases; a single dark pigmented, lateral eye spot; a tiny curved spine immediately anterior to eye. Antenna with 2–5 ring segments following scape (total segments 5–8); penultimate segment enlarged, bearing postapical peglike organ (sensory?) and 2 small setæ externolaterally; apical segment with one long principal seta and several minor ones. Prementum apically incised; labial palpus with 2–5 ring segments following basal segment (total segments 5–8). Cervical region (microthorax of Tillyard, 1916) with well-developed dorsolateral lobes.



Thoracic segments without noticeable sclerotized plates; mesothoracic spiracle in fold created by small anterior subsegment. Front legs somewhat more elongate and robust than middle and hind legs. Leg (fig. 21) with femur and tibia moderately compressed; tarsus distinct but capable of little or no movement on tibia; trochanter weakly defined; front claws blunt with anterior claw decidedly shorter than posterior one (fig. 17); claws of middle and hind pairs much smaller than front ones, unequal but not conspicuously so; paired pulvilli (or similar pads) at base of claws; empodium slender, trumpet-shaped, segmented in apical third, a second line of segmentation indistinct. Abdomen uniformly, weakly sclerotized; segments I–VIII with lateral spiracle in anterior third; each lateral margin of segments I–IX (on slide-mounted specimen) with two principal lobes, each lobe with a principal seta.

Coloration: Head gamboge yellow, somewhat darker above; thorax and abdomen uniformly pale, almost colorless; front claws light brown, middle and hind claws paler.

The supposedly mature larvæ of *americanus* range in length from 4.6 mm. to 12 mm., while the number of ring segments of the labial palpus and antenna vary as indicated above, and in several cases there is a difference of one segment in right and left appendages of the same specimen. The larva from College Park is the longest and has the largest number of antennal and palpal segments, but the one from Jackson's Island is the shortest (4.6 mm.) and has one more segment in each appendage than two larvæ from University Park examined in detail (4.8 mm. long, 5 segments in each appendage). The sex of these larvæ is naturally unknown, aside from the cast skin from which a male pupa developed. Adult males average definitely smaller than females. From the evidence now at hand, it is accordingly uncertain whether all or only part of these larvæ are fully developed, whether the number of palpal and antennal segments is variable from instar to instar, as well as in larvæ of the same instar, and whether sex has a bearing on size of

larvæ or number of palpal and antennal segments. Only one species of Dilaridæ is now recorded from the eastern United States. Most but not all Neuroptera have 3 larval instars.

*Pupa*.—The pupa illustrated (fig. 16) is near maturity, as evidenced by well-developed genitalia and wing venation, and dark color of the well-sclerotized portions of thorax and abdomen and on the apical two-thirds of tibia. The wings are practically black, except at the bases, and the *Nallachius*-type venation may be traced. Except as indicated by stippling on figure 16, the pupa is pale. Each antenna is a simple appendage, but the pectinations of the adult are visible within, wound about the central axis in spiral fashion. Body length is 3.26 mm.

The other pupa studied is not so near maturity as the one illustrated, and, though it is clearly a male, the dark areas are scarcely developed and the wing venation cannot be readily traced.

*Cocoon*.—The cocoon (fig. 3) is a tightly woven white sack without a visible exterior sculpture of any kind. The outer surface is covered loosely, and without regard to pattern, with clay-yellow particles, which appear to be fragments of wood. Others appear to be the excretory pellets of wood-feeding insects and are darker. Frass and various other particles frequently occur in the galleries of wood-boring insects, which explains their presence on the cocoon of *Nallachius*.

Material of *Nallachius americanus* examined<sup>3</sup> (previously unreported):

Adults.—Pittsburgh, Pa., all collected by Hugo Kahl: Fern Hollow, July 15, 1911, near orchard (1 ♂); Fern Hollow, August 6, 1907, on tree trunk near hilltop (1 ♀); Southern Avenue Park, July 8, 1911, in coitu (♂, ♀); opposite Homewood Cemetery, on an oak trunk, July 9, 1910 (1 ♀); Brookline, on tree trunk, July 17, 1910 (1 ♀).

Ingram, Pa., June 28, 1931, W. D. McIlroy, Jr. (2 ♂).

Odenton, Md., August 14, 1918, on *Robinia pseudacacia*, W. L. McAtee (1 ♂).

<sup>3</sup> All the Pennsylvania specimens except the two from Fern Hollow, July 15, and from Brookline, are deposited in the Carnegie Museum, Pittsburgh, Pa., all other material of both *Nallachius* and *Lomamyia* in the United States National Museum.



Bainbridge, Ga., April 6, 1943, at light, H. R. Dodge (1 ♂).

Larvæ and pupæ.—Jackson's Isl., Md. (also known as Scott's Isl. or Turkey Isl., located in Potomac River 11 miles above Washington, D. C.), found May 19, 1913, near a larva of *Micromalthus*, while breaking up wood fragments taken from a decaying log, May 5; rearing unsuccessful; dead June 9; many other kinds of larvæ in same log; E. A. Schwarz and H. S. Barber, 1 larva.

Greenbelt, Md., April 13, 1938, beneath bark of moist rotten log, W. H. Anderson, 1 larva.

College Park, Md., October 18, 1942, under bark of dead oak, W. H. Anderson, 1 larva.

University Park, Md., January 28, 1945, in hard dead tulip-tree wood in galleries of living larvae of *Pentarthrinus* and *Phlæophagus* weevils, W. H. Anderson, 4 larvæ. Two pupæ in cocoons recovered from same wood sample, but not in same gallery with the 4 larvae.

Langley, Va., November 1, 1939, with bark from tree, W. H. Anderson, 1 larva.

Biological notes: While the larvæ of *Nallachius* have not been observed feeding, there is no doubt that they attack other insects, as indicated by the piercing-sucking jaws and their presence within the galleries of wood-inhabiting insects. They themselves are not equipped to bore in wood, though the rather heavy claws, particularly those of the front legs, are presumably well adapted to locomotion in galleries often somewhat choked with the frass of their would-be victims. The integument of most of the larval body is pale and weakly sclerotized, apparently an adaptation to a minimum exposure to light and the open air. Most adults evidently emerge during spring and early summer. Apparently there is a single generation per year and a 1-year life cycle. A large percentage of adults recorded were collected on or about tree trunks, and eggs are probably inserted into the cracks of dead wood or the crevices of or beneath dead bark. Judging from the long ovipositor, it is extremely unlikely that the eggs are stalked.

## BEROTHIDÆ

The genus *Lomamyia* Banks

*Lomamyia* Banks, 1904,<sup>4</sup> Proc. Ent. Soc. Wash., vol. 6, p. 209.

Genotype: *Hemerobius flavicornis* Walk., by monotypy.

Two species, *flavicornis* and *banksi* Carp., are recorded from the vicinity of Washington, D. C., and it is possible that still others occur here, so the specific identity of the larvæ described below cannot be determined.

Immature stages of *Lomamyia*

*Eggs*.—While confined in a glass tube, a female collected at light on Plummer's Isl., Md., June 16, 1919, laid clustered stalked eggs similar to those of many Chrysopidæ. There was one cluster of 12 white eggs, each about 0.7 mm. long, attached to the end of a thread-like stalk 6 mm. long, the terminal end of the stalk being more slender than the base. There were several smaller and less perfect clusters. After 24 hours the eggs had transverse dark bars due to the development of banded embryos. Smith (1923, p. 139) has described a single infertile unstalked egg laid by a captive female of *Lomamyia*. The unstalked condition may have been abnormal.

*First-stage larva*.—General body shape (fig. 2) much as in *Nallachius*, head more elongate; jaws subequal in length to palpi and antennæ; 3 pairs of equal legs; maxilla dominant, with scalelike dorsal sculpture (fig. 8), the apical tenth specialized and weakly serrate (fig. 7); mandible reduced, slender, lateral; labial palpus and antenna 3-segmented, second and third segments each with numerous annulations. Front broadly produced; two lateral eye spots; cervical region and legs well developed; latero-dorsal thoracic sclerites absent or inconspicuous;<sup>5</sup> thorax and abdomen with conspicuous reddish purple transverse bands, as shown by stippling (fig. 2).

<sup>4</sup> The genus *Lomamyia* was first proposed in a list of species; the formal description appeared late the following year in Banks' revision of the Nearctic Hemerobiidæ.

<sup>5</sup> See Killington (1936, fig. 43, p. 97).



*Fully developed larva* (possibly more correctly described as a prepupa, though no cocoon is associated).—Abdomen much more enlarged than head, in contrast to first instar (fig. 5); legs reduced; jaws truncate, much shorter than palpi (loss of apices by fracture possible but uncertain); maxilla with conspicuous sculpture (fig. 12). Front more produced than in the first instar, broadly rounded; anterior half of median dorsal surface of head with broadly convex area poorly demarked; posterior half with pattern of pale sutures and 3 lateral setæ. Prementum small, irregular, anterior margin entire; mentum narrowed apically, broadly rounded basally, flanked by elongate sclerites (undifferentiated cardo and stipes?); cervical region with conspicuous, laterally concave apodemes, each with a detached, V-shaped base. Front and middle legs subequal (hind legs lost); tarsus rather freely articulated with tibia (fig. 22); trochanter distinct; tarsal claws equal; no observed pulvilli at base of claws; empodium apparently broadly incised apically, otherwise much as in *Nallachius*; a definite "sole" ventrad of claws (fig. 18). Pronotum with large paired laterodorsal sclerites on anterior two-thirds, a weak transverse suture on posterior third; meso- and metanotum each with small, narrow, semilunar sclerites; anal sucker apparently well developed.

Coloration: Head, cervical apodemes, thoracic sclerites, and coxæ brown; claws and "sole" pale brown; abdomen with poorly demarked dorsal pattern of light purple transverse bands; remainder pale. The unpublished notes of H. G. Hubbard contain the following description, made from life, of the Washington larva:

"General color is purple-brown, darker on thoracic segments and almost black on the head; lighter beneath; variegated with pure white. The legs and mouth organs are translucent white. Beneath, each abdominal segment has a large triangular spot of yellowish white, which looks like the luminous glands of *Lampyridæ*, but was found not luminous above or below. The dorsal surface is gaily decorated with snow-white markings—viz.: On prothorax, on each side, a narrow white line beginning behind the

middle; on meso- and metathorax, on each side, just above the legs a quadrate white spot; on second, third, fourth and fifth abdominal segments, also a narrow transverse band of white extending entirely across the segment near the hind margin, the ends of the bands enlarged, rounded and slightly curved forwards; the same white band on sixth and seventh segments but interrupted or less conspicuous (obsolete); the last two abdominal segments are pale and the terminal one is a suckerlike organ, not used in progression, but assisting the insect to cling to smooth surfaces, as in *Hemerobius*."

The slide-mounted Washington larva shows that the prothoracic laterodorsal sclerites bear several setæ, each arising from a well-developed pit. The sclerites of meso- and metanotum each bear a single posterior seta arising from a large pit. Other thoracic and abdominal setæ are sparse, inconspicuous, mainly arranged in transverse rows.

Both the Washington and Beltsville larvæ have the jaws proportionally much shorter than those of first-stage larvæ, but there is no definite fracture line, as described in *Osmylus* by Killington (1936, pp. 99, 224) and Withycombe (1923, p. 516), and the maxillæ of the Washington larva are not broken off evenly with the mandibles. Study of more material will be necessary to determine whether there is a normal shortening of the jaws subsequent to the first instar, whether there is a regular fracture prior to pupation, or whether the jaws of the two larvæ here studied were accidentally broken.

*Pupa*.—Unknown.

Material of *Lomamyia* examined:

Larvæ.—Washington, D. C., July 19, 1895. "Found in the fungus garden (nest) of *Atta occidentalis*<sup>6</sup> in wooded knoll, on Brentwood Road, near Soldiers' Home." H. G. Hubbard, 1 larva.

Beltsville, Md., October 28, 1941, in fallen log, in pocket containing living and dead termites, R. J. Kowal, 1 larva.

Plummer's Isl., Md. (located in Potomac River 8 miles

<sup>6</sup> My friend, M. R. Smith, has informed me that the ant in question was almost surely *Trachymyrmex septentrionalis* (McCook). Specimens are not known to have been preserved.



above Washington, D. C.), hatched from eggs laid by female collected at light June 16, 1919, H. S. Barber, 6 first-stage larvæ and several eggs.

Biological notes: The first-stage larvæ reared by Mr. Barber hatched from 2-day-old eggs and were kept in a vial. His notes and those of A. N. Caudell describe these larvæ as extremely active, running very rapidly on the smooth glass surface without use of the anal sucker. A crushed fly offered as food was not touched, and they attempted unsuccessfully to pierce larvæ of ants. Living larvæ and pupæ of Scolytidæ and immature termites proved very attractive. A larva would rush up to a victim, stop, then lunge forward and pierce the prey with the jaw of one side. After the jaw was withdrawn, the head would be turned to direct the jaw of the other side toward the prey, whereupon another lunge would be made. With a lens Mr. Caudell observed the jaws inserted into scolytid larvæ. It was seen that some of the *Lomamyia* larvæ increased in size, and the scolytid larvæ were dead the following day. The *Lomamyia* larvæ unfortunately died within a few days, perhaps due to a low atmospheric humidity.

There is no indication that the Beltsville larva (fig. 5) was removed from a cocoon; its robust abdomen and very small legs may point to a recent engorgement or a sedentary life, rather than preparation for pupation. Killington (1936, p. 128) should be consulted for a discussion of neuropterous prepupæ. The Washington larva (4.9 mm. long) is apparently in an earlier stage than the Beltsville specimen (9.36 mm.), and an enlarged abdomen is not evident, though its condition is somewhat unsatisfactory. It is suggestive of nest predatism<sup>7</sup> that one larva was taken among ants, the other among termites. I am inclined to believe that the later larval instars of *Lomamyia* are less active than those of *Nallachius*. Snyder (1920, p. 120) reported a strange neuropterous larva which he found in a termite colony at Falls Church, Va., in 1918. His notes lead one to suspect that the larva may

<sup>7</sup> Wheeler, *Ants*, 1926, p. 382, has discussed enemies living in ant nests, calling them synechthrans. True commensals are of a different nature, living at the expense of but without harm to the host.

have been *Lomamyia*, but the specimen is not now available.

Although the larval feeding mechanism of *Lomamyia* is specialized to function almost identically like that of *Nallachus*, the smaller legs of the mature *Lomamyia* larva, and the fact that the front leg and claws equal the middle ones, suggest somewhat different habits. Dr. Anderson consistently sought wood-inhabiting beetle larvæ in his collecting, and five times he secured *Nallachus* larvæ or pupæ, never *Lomamyia*. This fact suggests that *Lomamyia* larvæ occupy a different habitat.

The eggs of the Australian *Spermophorella* are borne on separate stalks, according to Tillyard (1916), and the first instars are much like those of *Lomamyia*. He reported that the larvæ walked with the combined use of legs and anal sucker, moving with a looping action similar to that of Geometridæ.

Principal larval characters distinguishing *Lomamyia* and *Nallachus*

<i>Lomamyia</i>	<i>Nallachus</i>
1. Penultimate antennal segment without subapical peg.	1. Subapical peg present.
2. Antennæ and palpi 3-segmented, no supernumerary segments.	2. More than 3-segmented, supernumerary segments present.
3. Maxilla much larger than mandible, dominant both ventrally and dorsally.	3. Mandible and maxilla subequal; mandible conspicuous dorsally, maxilla ventrally.
4. Antennæ borne at lateral extremities of head.	4. Antennal bases much less remote.
5. Anterior margin of front broadly rounded.	5. Anterior margin acute.
6. A single simple eye at each side of head.	6. Two simple eyes at each side.
7. Several ventral sclerites in region of mentum.	7. Ventral sclerites of head reduced in number.
8. Prementum apically entire.	8. Prementum apically divided.
9. Laterodorsal thoracic sclerites well developed.	9. Absent or indistinct.
10. Legs much reduced in proportion to abdomen (mature larva).	10. Legs only moderately reduced in proportion to abdomen.
11. Front legs equal to middle (and hind?) legs.	11. Front legs larger than middle and hind legs.
12. Claws equal.	12. Claws unequal, especially those of front legs.
13. Tarsal claws with a ventral "sole."	13. No "sole" present.
14. Tarso-tibial joint mobile; trochanter distinct.	14. Tarso-tibial joint apparently not mobile; trochanter poorly developed.



The foregoing generic characters are subject to modification as larvæ of other species become known. In sorting material, the subapical peg of the penultimate antennal segment of *Nallachius* and the sculptured dorsal surface of the maxilla of *Lomamyia* have been found particularly useful characters. The dominance of the maxilla in *Lomamyia* is one of the most fundamental differences between the two genera. Withycombe (1925, p. 328) has attached considerable significance to the relative dominance of mandible and maxilla in neuropterous families. Tillyard (1916) stated that the mandible of *Spermophorella* is dominant, but his figures indicate that the first instar larva (figs. 4, 10) is very much like that of *Lomamyia* (figs. 2, 8), and it is possible that he misinterpreted the mouthparts. If that be true, the close similarity of *Spermophorella* and *Lomamyia* larvæ strongly suggests the stability of larval family characters in the Berothidæ, even when represented by genera occurring in distant parts of the world.

#### FAMILY RELATIONSHIPS

The larvæ of neither the Berothidæ nor the Dilaridæ, as represented by the genera studied, may readily be confused with those of any other family. The terrestrial neuropterous larvæ most familiar to entomologists are Chrysopidæ and Hemerobiidæ. The latter are superficially suggestive of Berothidæ and Dilaridæ, but in each case, as in the hemerobiid genus *Wesmælius* (fig. 9), the jaws are strongly incurved, not extending straight forward. In fact, the berothids and dilarids clearly belong to what Withycombe (1925) has termed the straight-jawed families of Neuroptera, in contrast to the many families whose larvæ consistently have strongly incurved jaws. First-instar Hemerobiidæ have a trumpet-shaped empodium, but this becomes a broad pad in later instars (fig. 20). The Chrysopidæ is one of the very few families to retain a trumpet-shaped empodium in all larval instars (fig. 19). The well-illustrated key by Townsend (1935) will enable students to recognize the families of most Nearctic neuropterous larvæ.

Withycombe placed the Dilaridæ and Berothidæ, together with the Mantispidæ, Osmylidæ, Sisyridæ, and Myiodactylidæ, in a superfamily called the Osmyloidea. With the exception of the Myiodactylidæ, I believe that this grouping is entirely correct. Larvæ of the latter have been illustrated and described by Tillyard (1926, fig. U17), and, on the basis of larvæ, it seems clear that the family is related to the Ascalaphidæ and associated families. So far as I am aware, there was no description of myiodactylid larvæ prior to 1926, though Tillyard (1917, p. 543) mentioned the larva of *Myiodactylus* and indicated it would later be described. It is probable, therefore, that no information concerning these larvæ was available to Withycombe, and that the resemblance between Osmylidæ and Myiodactylidæ with respect to wing venation led him to associate closely the two families.

Klingstedt (1937) has suggested that the Dilaridæ may be closely related to the Raphidiodea, basing this view on chromosome structure. Tjeder (1937), who has studied the external and internal anatomy of adult Dilaridæ and Raphidiodea, points out both similarities and dissimilarities, and concludes that sufficiently close relationship is shown to justify transferring the Dilaridæ from the Neuroptera (strict sense, Planipennia of authors) to the Raphidiodea. Larval characters of the dilarids, previously unknown, impress me as more trustworthy indicators of relationship than the adult characters thus far studied, and consequently I believe the primary affinities of the Dilaridæ are with the Osmyloidea. The Berothidæ are close relatives.

The presence of an ovipositor in both raphidiids and dilarids has led Tjeder and others to suspect close relationship. A comparison of the adult female ovipositor of *Nallachus* (fig. 15) with those of mantispids of the genera *Symphrasis* and *Plega*, and with those of the raphidiid genera *Agulla* and *Inocellia* shows that there is an abrupt bend or elbow at the base of the ovipositor in the first two families which is absent from the Raphidiodea. In several other ways the Mantispidæ suggest

affinities with *Nallachus* and *Lomamyia* that appear stronger than any shown by the raphidiids.<sup>8</sup> Trichosors or marginal dots and dashes of the wings, discussed by Killington (1936, p. 34) and Comstock (1918, p. 167), occur in Dilaridæ, Berothidæ, and some Mantispidæ, as well as certain other families, but not in the Raphidiidæ that I have examined. The swollen body and reduced legs of mature *Lomamyia* larvæ suggest an approach to the parasitic habit, with even more swollen body, of Mantispidæ. The claws and empodium, as well as certain other structures discussed by Withycombe (1925), of first-stage larvæ of Mantispidæ are very similar to those of *Lomamyia*. I have examined larvæ of an unidentified mantispid found by J. C. Bridwell in 1938 in alcohol in which spiders had been collected. In addition to the Nymphidæ and Myiodactylidæ, the Berothidæ, Mantispidæ, and Chrysopidæ are known to lay stalked eggs. While raptorial front legs give the Mantispidæ a quite different superficial appearance from either Dilaridæ or Berothidæ, they are regarded by Withycombe (1925, p. 329) as a specialization rather than as evidence of fundamental lack of relationship.

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<sup>8</sup> Students are referred to two papers on the adult morphology of Raphidiidæ and Mantispidæ, by Ferris and Pennebaker (1939) and Ferris (1940).



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## ABBREVIATIONS

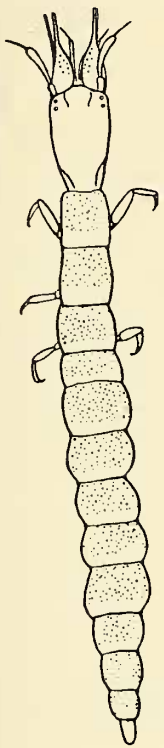
er = cervical region	ob = base of ovipositor
ex = coxa	pe = sensory (?) peg of antenna
ds = dorsolateral thoracic sclerites of pronotum	pm = prementum
em = empodium	so = "sole" of tarsal claws
fe = femur	S7 = seventh sternum
m = mentum	ta = tarsus
md = mandible	ti = tibia
mx = maxilla	tr = trochanter

(Figure 3 drawn by Arthur D. Cushman, other drawings by the author.)

## PLATE 11

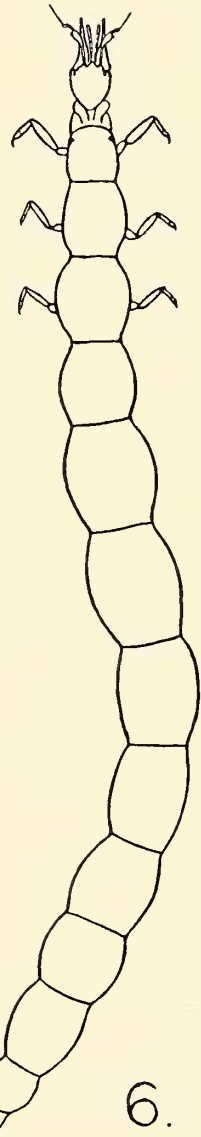
- Fig. 2. *Lomamyia* sp., first-instar larva, dorsal view, right middle leg missing. Length, 2.04 mm.
- Fig. 3. *Nallachius americanus*, cocoon. Length, 3.26 mm.
- Fig. 4. *Spermophorella disseminata* Till., first-instar larva, dorsal view. Length, about 2.5 mm. (Adapted from Tillyard, Proc. Linn. Soc. N. S. Wales, vol. 41, pl. 18, fig. 32, 1916.)
- Fig. 5. *Lomamyia* sp., mature larva, dorsal view. Beltsville, Md. Length, 9.36 mm.
- Fig. 6. *Nallachius americanus*, mature larva, dorsal view. College Park, Md. Length, 12 mm.





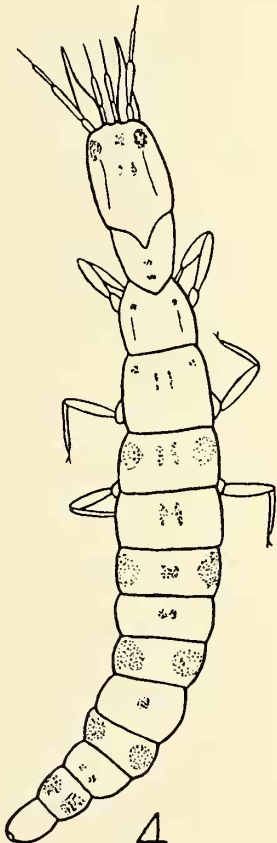
3. *Nallachus*

2. *Lomamyia*



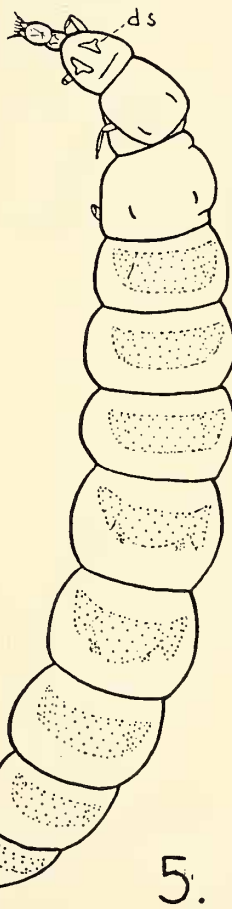
6.

*Nallachus*



4.

*Spermophorella*

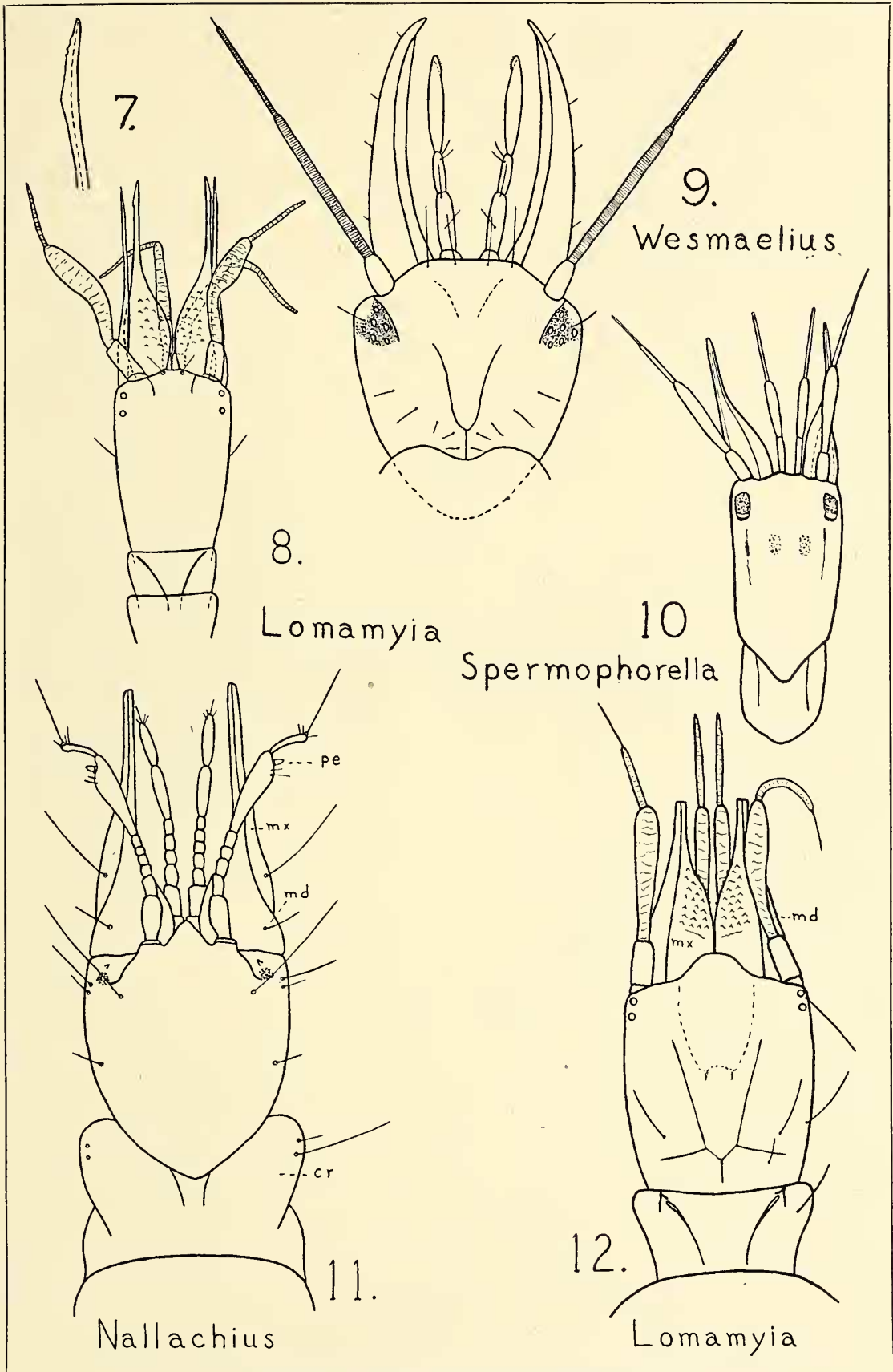


5.

*Lomamyia*

## PLATE 12

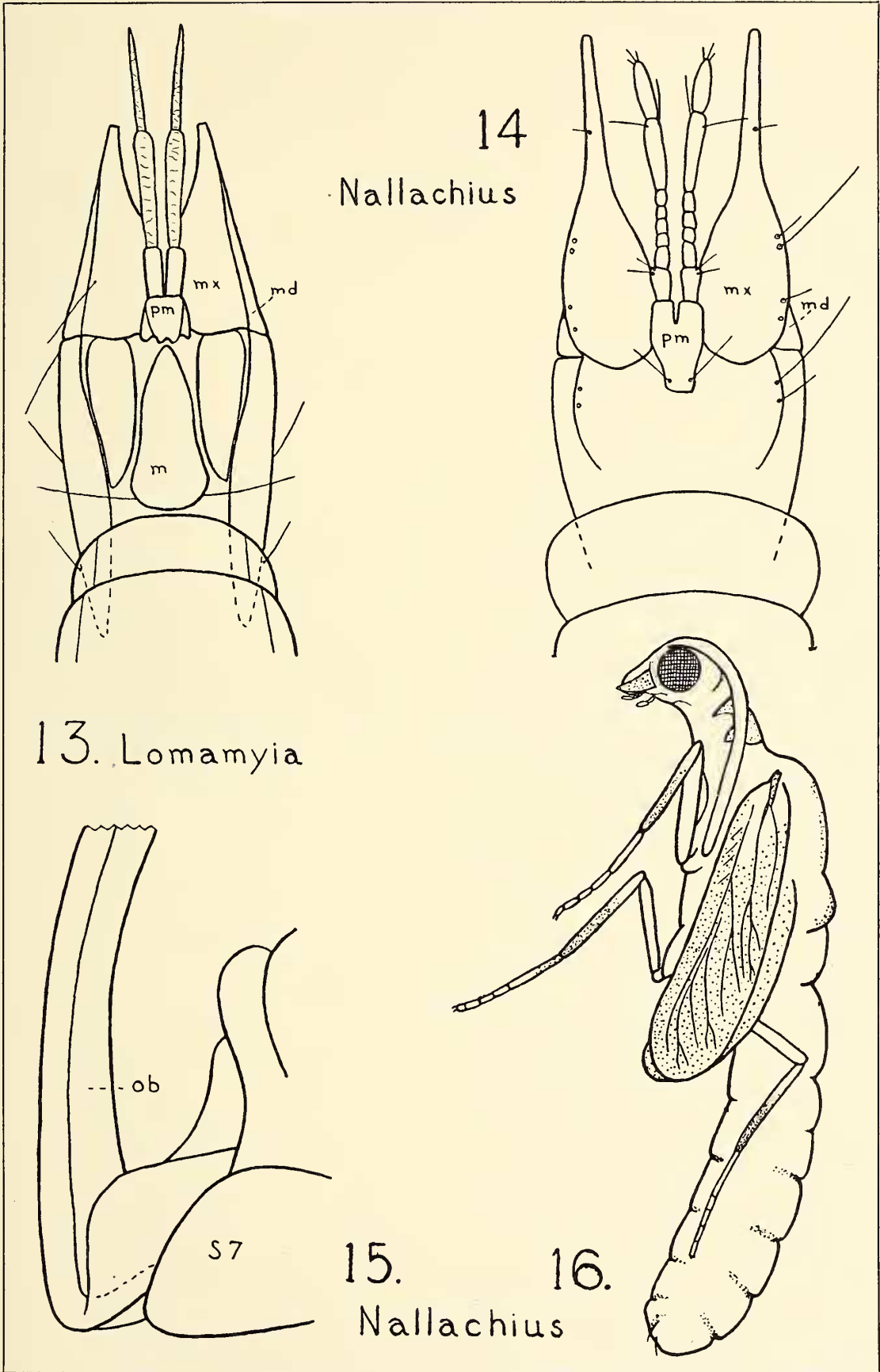
- Fig. 7. *Lomamyia* sp., first-instar larva, apical fourth of left maxilla, dorsal view.
- Fig. 8. Same specimen as fig. 7, dorsal view of head.
- Fig. 9. *Wesmaelius quadrifasciatus* (Reut.), mature larva, dorsal view of head. (Adapted from Killington, A Monograph of the British Neuroptera, vol. 1, fig. 44, A, 1936.)
- Fig. 10. *Spermophorella disseminata*, first-instar larva, dorsal view of head and neck. (Adapted from Tillyard, l. c., fig. 33.)
- Fig. 11. *Nallachius americanus*, mature larva, dorsal view of head and neck. Same specimen as in fig. 6.
- Fig. 12. *Lomamyia* sp., mature larva, dorsal view of head and neck. Same specimen as fig. 5.





## PLATE 13

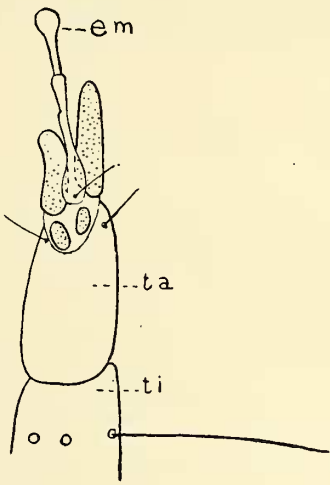
- Fig. 13. Same specimen as fig. 12, ventral view of head and neck, antennæ omitted.
- Fig. 14. *Nallachius americanus*, mature larva, ventral view of head and neck, antennæ omitted. Same specimen as fig. 6.
- Fig. 15. Same, adult female, right lateral view of apex of abdomen, only base of ovipositor shown. Brookline, Pittsburgh, Pa.
- Fig. 16. Same, pupa, left lateral view. Length, 3.26 mm.



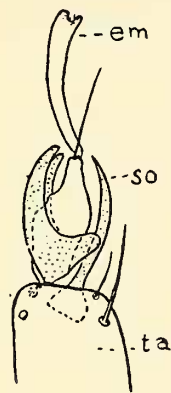
## PLATE 14

- Fig. 17. Same, apex of right front leg, ventral view. University Park, Md.  
Fig. 18. *Lomamyia* sp., apex of left middle leg, anteriolateral view. Same specimen as fig. 5.  
Fig. 19. *Chrysopa* sp., apex of right middle leg, ventrolateral view. Chipley, Fla.  
Fig. 20. Unidentified hemerobiid, apex of right middle leg, ventrolateral view. Mexico.  
Fig. 21. *Nallachius americanus*, mature or nearly mature larva, right front leg, anterior surface, femur turned into ventrolateral view, only coxal attachments shown. Greenbelt, Md.  
Fig. 22. *Lomamyia* sp., mature larva, right front leg, anteriolateral view. Same specimen as fig. 5.

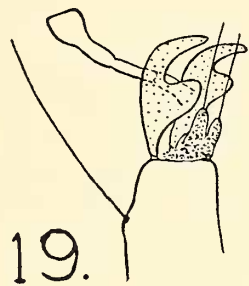




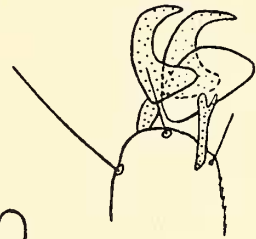
17. *Nallachus*



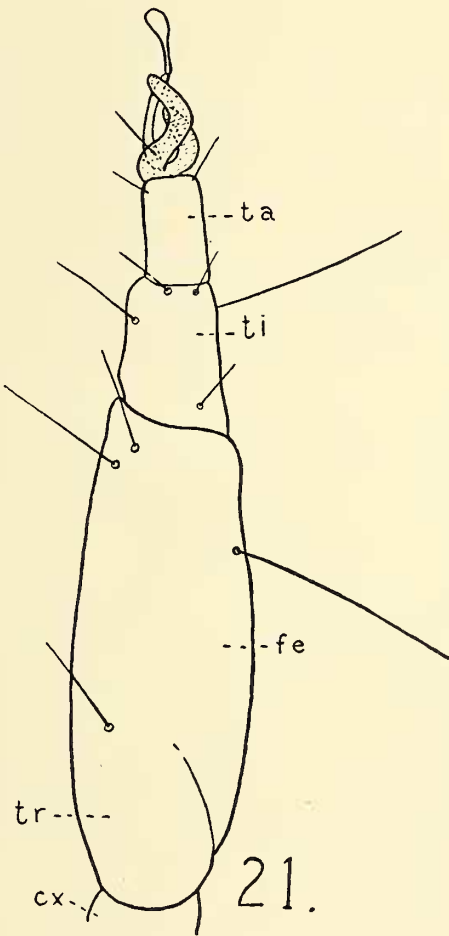
18. *Lomamyia*



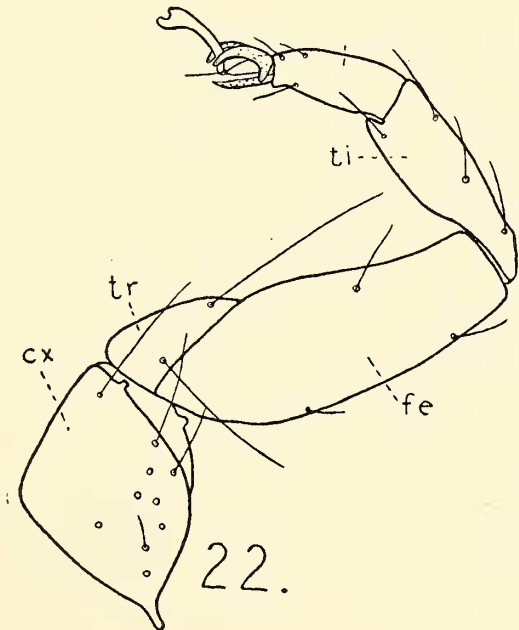
19. *Chrysopa*



20. Hemerobiid



21. *Nallachus*



22. *Lomamyia*